RAISED FLOOR SYSTEMS

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¦ 1. Character(s) preceded & followed by these symbols (+ +) or (+ +)
¦¦ are super- or subscripted, respectively. ¦
¦ EXAMPLES: 42m+3+ = 42 cubic meters ¦
¦ CO+2+ = carbon dioxide ¦
¦ ¦
¦ 2. All degree symbols have been replaced with the word deg.¦
¦ ¦
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¦
¦¦ 4. All table note letters and numbers have been enclosed in square brackets in both the table and below the table. ¦
¦¦ 5. Whenever possible, mathematical symbols have been replaced with their proper name and enclosed in square brackets. ¦
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List of Figures

2. Air Registers.
3. Panel to Pedestel Cap Connections.
4. Section at Borders.
5. Section at Depressed Slab.
6. Underfloor Bracing.
7. Section at Step.
8. Section at Closure.
9. Longitudinal Section at Ramp.
10. Pedestal Detail.
11. Stringerless Type Construction.
12. Stringer Type Construction.
13. Aluminum Panel.
14. Hollow Formed Steel Panel.
15. Cementitious Filled Panel.
16. Wood Core Panel.
17. Concrete Panel.

*This manual supersedes TM 5-805-13/AFM 88-4, Chap. 9,

dated September 1981.

1. Purpose.
This manual provides guidance for determining the requirements for raised floor systems.

2. Scope.

This manual describes raised floor systems and the requirements that mustbe considered in selecting an appropriate flooring system. Raised floors are for installation over structural floors to provide an accessible space below the finished working surface for installation and servicing of conduit, wiring, ducts, or other items, and/or to provide an air conditioning plenum. Raised floor systems include manufacturers’ standard floor panels, pedestals, and accessory items such as stringers, steps, ramps, railings, closures, and
trim needed to complete the installation. Figure 1 illustrates typical raised floor system construction.
[retrieve Figure 1]

Appendix A contains a list of references used in this document.

4. Applications.
Equipment/computer rooms and general offices are the two most common environments in which raised flooring systems are found. The function and performance requirements placed on the raised floor in these environments are very different and require separate analyses.

5. Design Considerations.
Raised flooring systems were originally developed for use in data processing areas to eliminate exposed cabling on the floor and the

inherent hazards. Removable panels provided access to the cabling to simplify maintenance and to provide for changes in the cable to meet new equipment requirements. Today, however, the use of this flooring system has been expanded to serve many other types of occupancy, most notably open office flooring to simplify access to utilities and cabling. The initial cost of the system is usually offset by the simplicity of the movable work stations and associated power and communication layouts that can be used with the floor system. Raised floors are composed of manufactured standard products of known structural properties.

Structural properties of all components are determined using the Ceilings & Interior Systems Construction Association (CISCA) Recommended Test Procedures for Access Floors which have been accepted by the industry. The DOE/EP-0108 standard will be followed closely when specifying raised floor systems in computer environments. Building designers are responsible for defining the requirements for the floors. Flooring manufacturers will develop the detailed floor design to satisfy the requirements.

a. General. Raised floors must be designed to accommodate the equipment and activities intended for the building space. All floors will be subjected to static, rolling, and impact loading. In equipment rooms such as computer rooms and laboratories, the primary design concern is to support large static loads and provide quick access to the space below the floor. Design of access floors in general offices, in addition to loading requirements, must consider acoustical performance and floor coverings. General design considerations include equipment dead loading, dynamic loading resulting from moving equipment on the floor, utility cutouts, space dimensions, electrical service, air conditioning, safety, the use of fixed panels for additional stability, and the space under the floor to accommodate cabling and utility systems.

b. Utility Loads. Raised floor loads, signal cables, power cables,and ducts must be considered when designing the supporting structural floor. The future use of these underfloor spaces must be taken into consideration so as to provide some operational flexibility.

c. Seismic Loading. Potential seismic loading must be considered in designing raised floor systems. Raised floors can fail due to unconstrained lateral motion causing the cantilevered pedestals to fail and overturn. Almost all floor manufacturers offer a variety of ways to cross brace supporting systems to reduce the possibility of pedestal failure. Pedestal base plates in buildings in seismic zones 2, 3, or 4 shall be secured to the structural floor with expansion anchors to increase resistance to overturning. If the pedestals are installed over a floor system that will not readily accept anchors, the base plates can be enlarged to increase resistance to the overturning forces. The Uniform Building Code (UBC) will be used in determining performance requirements. There are three types of flooring installations to be considered:

(1) Type I: Raised floors completely surrounded by building

walls.
Type I floors are the most resistant to seismic loading; structural failure and displacement of the surrounding walls must occur before the raised floor can be damaged.

(2) Type II: Raised floors with part of the edge exposed and not retained by other structural elements. Type II floors are less resistant to seismic loading along the axis of the unconstrained side. Seismic loading on Type II floors is resisted by two methods. In one method the perimeter panels of all floors are secured to the supporting structural framing and the panels fit tightly together to minimize lateral motion. In the other method, the structural framing is modified with cross bracing, to resist the overturning motion.

(3) Type III: Free standing raised floors without lateral contact with other structural elements. Type III floors are primarily strengthened elements. Type III floors are primarily strengthened with cross bracing to resist loads defined by the UBC.

d. Plenum Requirements. The space under the raised floor may be used as an air plenum in the cooling/heating system. The Department of Defense MIL-HDBK1008A will be followed when specifying the underfloor space to be used as a plenum. As a plenum, the entire space under the access floor is used either to supply conditioned air into the space above or to act as a return duct.
Air flow requirements must be specified to ensure that an adequate vent area is provided through the

floor. The exact types and numbers of perforated panels or the grille area must be determined. See figure 2 for details. The use of grilles and dampers may be somewhat restricted depending on the panel type, equipment placement, operating space, and traffic patterns. Reinforcing ribs and stringers should not be cut when installing grilles in metal panels and concrete panels. The loss of air between floor panels can also affect the number and size of air distribution panels necessary for proper air distribution. The amount of air leakage acceptable between the panels should be specified as a performance requirement for the system. Design of the plenum should be coordinated with mechanical, electrical, and fire protection consultants. If electrical devices are placed under a raised floor system over a concrete slab on grade, measures should be taken to control moisture and provide water drainage; the condition may justify the installation of moisture detection devices.
[retrieve Figure 2]

e. Radon Remediation. Where raised floor systems are installed over slab on grade floor or in below grade spaces, the design will include provision to remove excess radon gas if required by post construction measurement of radon concentration exceeding 4 picocuries per liter (4pCi/L). Blanked-off supply and exhaust ducts that can be readily activated will be installed to the floor cavity when required for radon removal. If the floor cavity is designed to be used as an air plenum the blanked-off ducts will be omitted and the HVAC system designed so that the air exchange rate can be increased to dilute and exhaust the excessive radon concentration.

f. Responsibilities. The Contractor should be given full responsibility for designing the floor system to meet the loading requirements and for submitting calculations to prove the designs' adequacy and conformance with deflection requirements.

6. Raised Floor Construction.

a. Structural. Pedestals, stringers, and panels are structural components. Stringers are optional in developing the panel strength, but they may be required to resist horizontal loadings or seismic forces. The components should be designed with the expectation that changes in the use of the
raised floor may occur. Perforated panels are designed and produced to carry the same concentrated loads as unperforated standard panels. Cutouts in the floor should not impair the panel strength, and should be reinforced to maintain the panel load-carrying ability.

b. Panel Support Systems. The two most common methods of attaching floor panels to the support system are by bolting and gravity. Corner lockand snapon stringer methods are also used. Gravity-held systems allow easier access but may reduce lateral stability and load-carrying ability. Bolted systems are more rigid and can take greater loads, particularly rolling loads. They also provide a firmer feeling than the gravity-held systems. Bolted panels require that fasteners be exposed on the finished panel surface except when free laid carpeting is used. Lateral stability is provided several ways in addition to the use of stringers. Panels around the perimeter of the floor must be fastened to the supporting components to form a rigid boundary for the interior panels. Lateral bracing can include the use of wires or other tension members installed under the floor. See figures 3, 4, 5, and 6 for details.

[retrieve Figure 3]
[retrieve Figure 4]
[retrieve Figure 5]
[retrieve Figure 6]

c. Portability and Interchangeability. Raised floor system components
are modular elements and can be salvaged from one space and reerected in a new
space. In such an activity, it may be more economical to procure new pedestal bases than salvage existing ones. Since all panel dimensions are the same in the United States, flexibility among installations is assured. Selecting a common panel dimension for a series of installations will add operational flexibility.

d. Finish. Ferrous metal surfaces must be protected from corrosion by galvanizing or shop painting. Tops of panels must be finished with a floor covering material. Panel sides must be finished with vinyl to protect the edge of the floor covering material if the panel is not carpeted. Panel cutouts must be edged with plastic and provided with soft rubber pads for sealing between the panels and penetrations (electrical cutout with plastic insert does not need soft rubber pad). Floor covering may be specified to

be vinyl, rubber, conductive high pressure laminate, high pressure laminate, conductive vinyl materials, or carpet. Vinyl and rubber materials are to be avoided where heavy concentrated loads will be applied or where some degree of electrical conductivity is required. High pressure laminate is suitable for use where a high resistance to indentation, a small degree of electrical conductivity, and maintenance without the use of wax is required. Such laminates are most often used in computer rooms and are available in both 1/16 inch and 1/8 inch thicknesses. Conductive vinyl is suitable for use in computer rooms when operating personnel will be required to wear conductive footwear to prevent the build-up of static electricity, and a specified conductivity requirement is included in the contract specifications. Conductive high pressure laminate is suitable for use where both the electrical characteristics of conductive vinyl and the wear characteristics of high pressure laminate are desired. Carpet can be either laminated to the panel or free laid on the installed floor. If factory laminated carpet is used, panels may have to be returned to the floor manufacturer for carpet replacement. Free-laid carpet tiles allow replacement of the carpet without removing panels and are most popular for use in open office areas. Carpets that will reduce static generation
are available. High pressure laminate, conductive vinyl, conductive high pressure laminate, and carpet will be used only when absolutely necessary to meet job requirements.

e. Accessories and Trim. Registers, grilles, perforated panels, and plenum dividers are all necessary elements of a flooring system that uses the underfloor space as an air plenum. All accessories will be of the manufacturer’s standard type and designed to support the same static loads as unaltered floor panels, while also delivering the air volumes required. Plenum dividers should be adjustable to facilitate creating air seals at variations in the floor level. When electrical or plumbing work penetrates these partitions, the openings must be sealed to prevent air flow around the penetrations. Edge trim is used to protect the edge of the floor panel while also protecting the edges of tiles or carpets (if used) from chipping or fraying. Time can also be used to form the seal necessary to prevent air leakage from between the panels and prevent dust and other particles from entering the underfloor area. Consideration should be given to sealing concrete structural floors in an attempt to control dust and vapor emission. When using concrete panels in areas where dust-sensitive computer equipment is to be installed, verify that the panel is acceptable to the using agency. Current Air Force criteria do not permit the use of concrete panels in mainframe computer environments.

f. Ramps and Steps. Most manufacturers offer integrated ramp and step units to match their panels. These units may be more difficult to fit in place than on-the-job fabricated units because they usually require special transition segments. Since floor panel coverings may be slippery, ramps should be surfaced with rubber or with added non-slip features. The height of step risers should not exceed 7 inches; slopes should not exceed 1 inch rise to 10 inches of run. Where accessibility to the physically handicapped is required, ramp slopes should not exceed 1 inch rise to 12 inches of run. See figures 7, 8, and 9 for details.

[retrieve Figure 7]

[retrieve Figure 8]

[retrieve Figure 9]

7. Support System.

Flooring systems are supported on pedestals supported by the underlying structural floor. Stringers may be used to interconnect the pedestal heads to improve panel edge support and lateral stability in the installed floor. Techniques for providing lateral bracing are discussed in the following paragraphs.

a. Pedestals. Pedestals consist of a base plate, post, and an adjustable head. The base plate transfers the load to the structural subfloor and is made from either steel or aluminum. It is normally held in place with an adhesive and must be in full contact with the subfloor surface. Pedestals 24 inches high or higher will be securely anchored to the structural floor in addition to the adhesive. Although pedestals are available from 6 inches through 96 inches high, lateral stability is not ordinarily a problem for floor heights less than 12 inches. Minimum pedestal height for Air Force projects is 12 inches. All pedestals have some means to control the vertical height so that the finished floor can be leveled regardless of variation in the supporting slab. Pedestal height is adjusted by moving an elevating nut to the desired height on the threaded post. Each nut is equipped with a positive locking device in order to maintain its vertical position. See figure 10 for details.

[retrieve Figure 10]

b. Stringers. Each support system is available as either a stringer or stringerless system. The contractor is given the option of selecting the final configuration; however, stringerless systems should not exceed a height of 12 inches. A stringer is a horizontal framing member that connects the pedestal heads, supports the panel edges, and adds lateral stability to the floor system. Stringers also come in two types: snap-in and bolted. Snap-in stringers are easier to remove than bolted stringers. In a bolted support system, the stringers are mechanically fixed to the pedestal caps. Most stability support systems are made of steel, but some manufacturers offer aluminum stringers and pedestal heads. See figures 11 and 12 for details.

[retrieve Figure 11]

[retrieve Figure 12]

8. Floor Panels.

There are five different floor panels: aluminum, hollow formed steel, metal-clad cementitious fill, metal-clad wood core, and concrete. Nonferrous materials should be used in areas where there is potential for damage by rust oxides or paint flakes. In accordance with CISCA Test Method, hollow panels should have a safety factor of 2 and filled panels should have a safety factor of 3 in terms of ultimate load. In general, all panels perform will under static and impact loadings.

a. Aluminum. Die cast aluminum panels (fig. 13) are lightweight and have very little variation in dimension from panel to panel. Aluminum panels have the advantage of being acceptable in places where nonferrous materials are required (e.g., Magnetic Resonance Imagery rooms), but they tend to be significantly more expensive than other types of panels.

[retrieve Figure 13]

b. Hollow Formed Steel. Die-formed hollow steel panels (fig. 14) perform best under static loads and should not be used under dynamic (rolling) loads. The panels have die-formed bottom sheets and smooth top sheets that are welded together along the edges. This panel is more economical than other types of panels and can be provided by most flooring system manufacturers.

[retrieve Figure 14]

c. Metal-Clad Cementitious Fill. The cementitious core fill is enclosed in steel sheeting to create a composite structural panel. The panel (fig. 15) is designed to improve resistance to rolling and impact loads using the cementitious core to fully support the top sheet. Specific strength and loading capabilities vary with each manufacturer and should be specified wherever it is a critical concern. This panel is quieter due to its mass and usually costs slightly more than the standard formed steel panels.

[retrieve Figure 15]

d. Metal-Clad Wood Core. The wood core panel (fig. 16) is the most economical panel and consists of a core of particleboard with an overlapping skin of galvanized steel. The wood core acts as a sound deadener and insulator, and increases resistance to rolling loads. The core is a thermal barrier separating the two spaces, reducing the cold floor feeling and providing better control of air plenum temperatures.

Wood core panels can be easily cut and trimmed, however, doing so causes loss of fire retardancy and UL rating. The edges of the wood core panels must be protected from moisture in order to prevent warping.

[retrieve Figure 16]

e. Concrete. Lightweight concrete panels (fig. 17) are either solid or metal-clad. These panels perform very well under dynamic loadings, with little chance of surface deformation. They weigh approximately 40 pounds per square foot. The edge support is achieved by thickened edges cast integrally with the panel. Concrete panels are used primarily for office flooring and are typically similar in cost to cementitious fill panels.

[retrieve Figure 17]

9. Fire Safety

a. Fire Resistance. Raised floor systems will be constructed of noncombustible materials, except for wood cores, floor coverings, and plastic materials used for trim, edging, cut-out closures, and pads. Under no circumstances may combustible materials be located within the under-thefloor space when used as an air plenum. All electrical wiring passing through the air plenum, including telephone and communication wiring, will be in metal conduit. Noncombustible materials are those materials which with either not burn or have a flame spread rating of 25 or less when tested in accordance with ASTM Standard E 84.

b. Fire Suppression.

(1) In designing the raised floor system for computer rooms, consideration should be given to providing an automatic sprinkler system for the room when:

(a) The computer room construction contains any combustible materials other than permitted in NFPA 75, Section 2-3.1 or:

(b) The enclosure of a unit in a computer system, or the unit structure, is built all or in part of a significant quantity of combustible materials. or:

(c) The operation of the computer room involves a significant quantity of combustible materials.

(2) A Halon 1301 total flooding system will be provided in electronic equipment spaces only where strategically important functions vital to our national defense are conducted and continued operation of equipment is absolutely necessary to ongoing strategic military operations. Where operation of the air handling system would exhaust the agent supply, the Halon system will be interlocked to shut down the air handling system when the Halon system is actuated.

c. Water Protection. The structural floor that supports a raisedfloor installation shall incorporate provisions for draining the floor surface to minimize damage to the system and associated wiring caused by domestic water leakage, sprinkler operation coolant leakage, or fire fighting operations. Halon fire suppression systems will not be used on Air Force facilities.

10. Electrical Conductivity.

All electrical equipment installed on the floor should be grounded independently from the flooring system. Metal parts of the raised floor system will be electrically continuous and connected to an external ground. Electrical contacts between components should result from the normal bearing of one component upon another in their installed position. Care should be taken to prevent seals between panels from interfering with the metal-tometal contact needed to maintain continuity of the grounding system. Static electricity generated by personnel within the space is also a problem. Under some circumstances, static electricity can seriously affect the computer operation. Maintaining the humidity level in the room at a constant 50 percent will minimize static buildup. In areas more sensitive to static discharge, as in hospital operating rooms or areas with highly volatile or explosive elements, an appropriate conductive floor finish should be used to transfer static charges to the grounded framework.

APPENDIX A

REFERENCES

Government Publications.

Department of Defense

MIL-HDBK-1008 Fire Protection for Facilities Engineering, Design and Construction. Department of Energy

DOE-EP-0108 Standard for Fire Protection of DOE Electronic Computer/Data Processing Systems.

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National Fire Protection Association (NFPA), Batterymarch Park, MA 02269. 75

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